California Energy Commission

Water Energy Research and Implementation

Nancy Jenkins, P.E.

Manager, Energy Efficiency Research Office

March 28, 2006

Public Interest Energy Research Program (PIER)

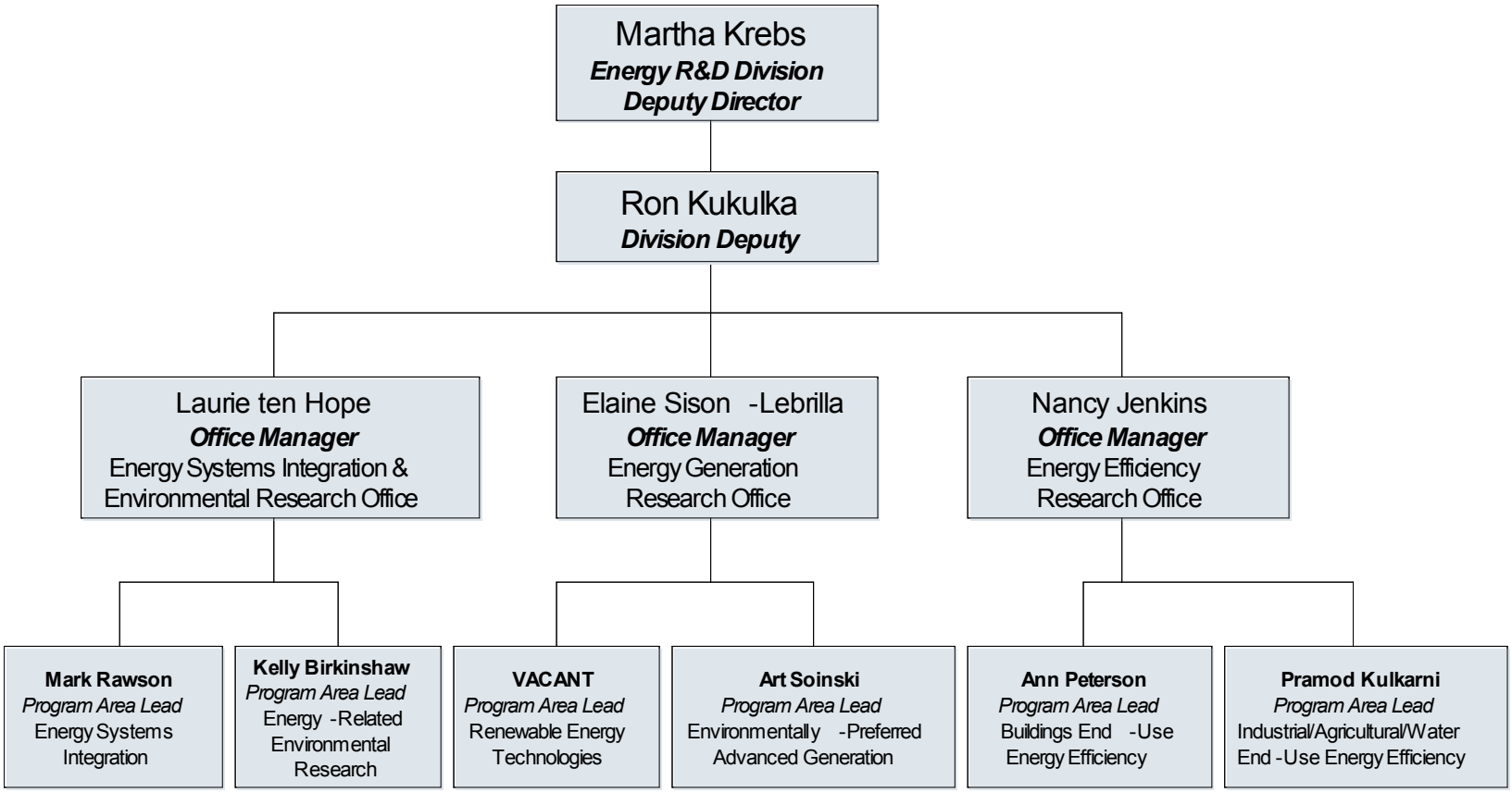
- Initiated in 1998 as a part of California electricity deregulation and funded at $62M/Yr

  - It's the research counterpart to the public goods energy efficiency program administered by the utilities and the Renewables Program administered by the CEC

  - The mission of PIER is to conduct public interest energy research that seeks to improve the quality of life...by providing environmentally sound, safe, reliable and affordable energy services and products

  - In 2005, the program expanded to include natural gas research starting at $12M/year and increasing to cap of $24M/yr in 5 years

PIER Organization



Public Interest Energy Research Program (PIER)

• **The PIER Industrial/Ag/Water Program** develops new technologies in to increase energy efficiency and reduce emissions and manufacturing costs for California industries, agriculture, and municipal water and wastewater systems.

• **The PIER Environmental Program** develops cost-effective approaches to evaluating and resolving environmental effects of energy production, delivery and use and explore how new energy applications and products can solve environmental problems.

• **The PIER Buildings Program** develops new or improved energy-related technologies, design strategies, energy management tools, construction practices, and operational strategies to improve energy efficiency in buildings.

Water Energy R&D
PIER Environmental Program

- *Major program efforts focus on*
  - *Ways to reduce freshwater consumption by the thermal electricity generating sector*
  - *Ways to reduce impacts on aquatic species and habitats from the electricity generating sector*
  - *Ways to enhance hydropower generation with existing infrastructure.*
  - *Provide analytical tools to improve the understanding of the environmental effects of the use of energy by the water sector*

Water Energy R&D

PIER Environmental Program

Problem: ***How do you reduce water consumption by power plants? A modern 500 MW power plant can consume as much water as a city of 12,000 people. Dry cooling can reduce this water use by up to 95% but with a performance penalty during the hottest hours of the year.***

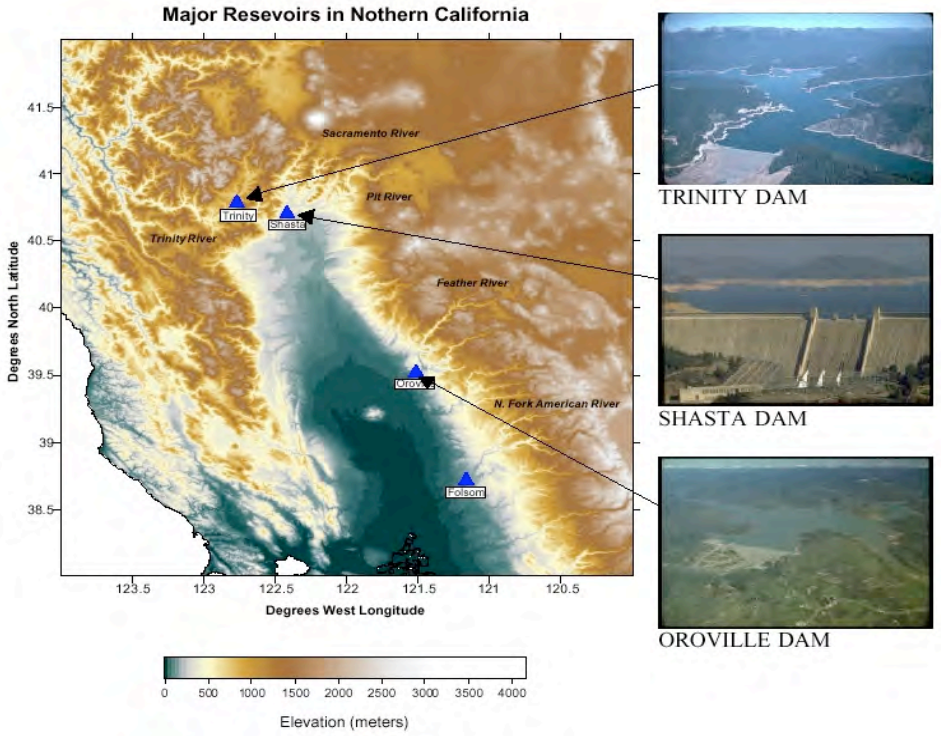
Solution: ***Research has demonstrated that 75% of this lost capacity can be recovered by introducing just a small spray of water into the air passing through the dry cooling towers. Other on-going efforts to improve dry cooling performance include modeling the effects of wind and evaluating measures to reduce air recirculation effects.***

Water Energy R&D

PIER Environmental Program

Problem: ***How do you maximize hydropower generation and water supply at large, multipurpose reservoirs while ensuring environmental protection including flood control?***

Solution: ***Development of probabilistic runoff forecasts that can give reservoir managers greater confidence in their decisions as well as development of decision support models that help managers balance competing water demands.***



Water Energy R&D
PIER Environmental Program

Problem: ***How do you reduce the ecological effects of ramping flows from hydropower facilities? These flows may increase hundreds of times greater than base flow levels and then just as quickly subside.***

Solution: ***Conduct research that improves our understanding of the ecological effects of such flows, develop tools and protocols that improves our ability to assess the effects of such flows and evaluate and demonstrate measures that can reduce the severity of these effects.***

Water Energy R&D
PIER Environmental Program

Problem: ***How do you reduce the ecological effects of the use of once-through cooling technology? This cooling technology is used in a number of power plants located along California's coast and bays.***

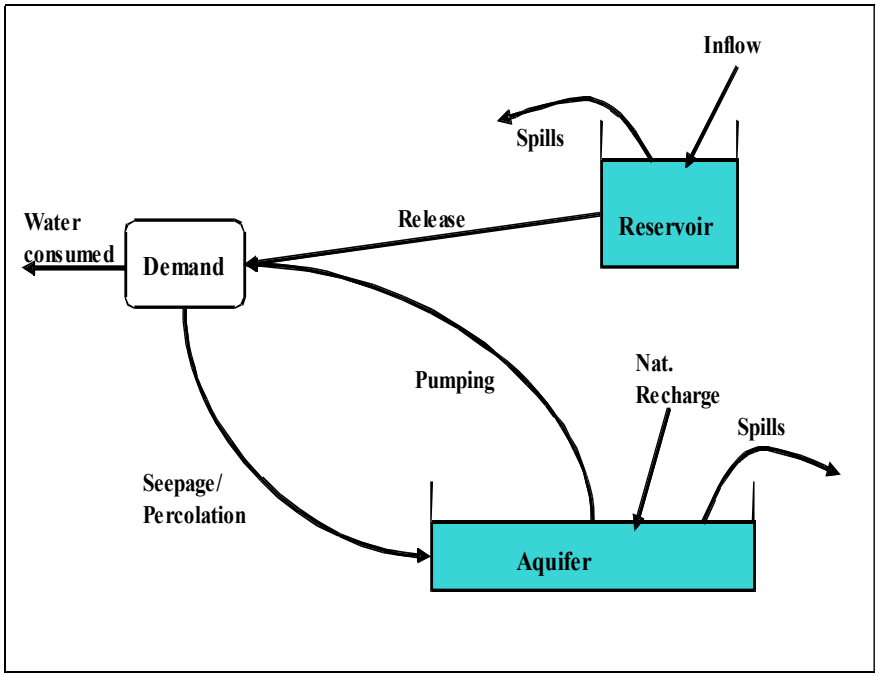
Solution: ***Conduct research that improves our understanding of the ecological effects of this cooling technology, develop tools and protocols that improves our ability to assess the effects of such flows and evaluate and demonstrate measures that can reduce the severity of these effects.***

Water Energy R&D

PIER Environmental Program

Problem: ***Under drought conditions, what is the best way to manage surface and groundwater supplies? What are the energy consequences of these management approaches?***

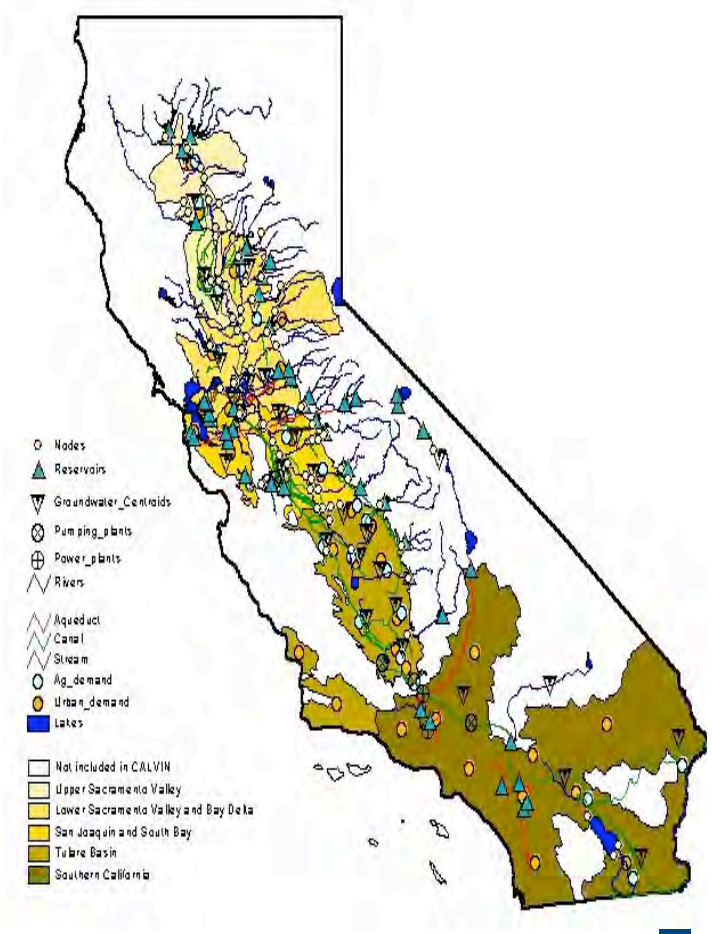
Solution: ***Develop a model to assess water supply and energy consequences of variable climate and water management decisions.***



Water Energy R&D
PIER Environmental Program

Problem: ***What will be the effect of global climate change on California's water and energy supply? While some potential effects are evident now, much is still not known about what the effects of climate change will mean for California.***

Solution: ***Fund research that improves our understanding of potential global climate change effects on California, and explore potential mitigation/adaptation measures to help Californians to cope with such effects.***

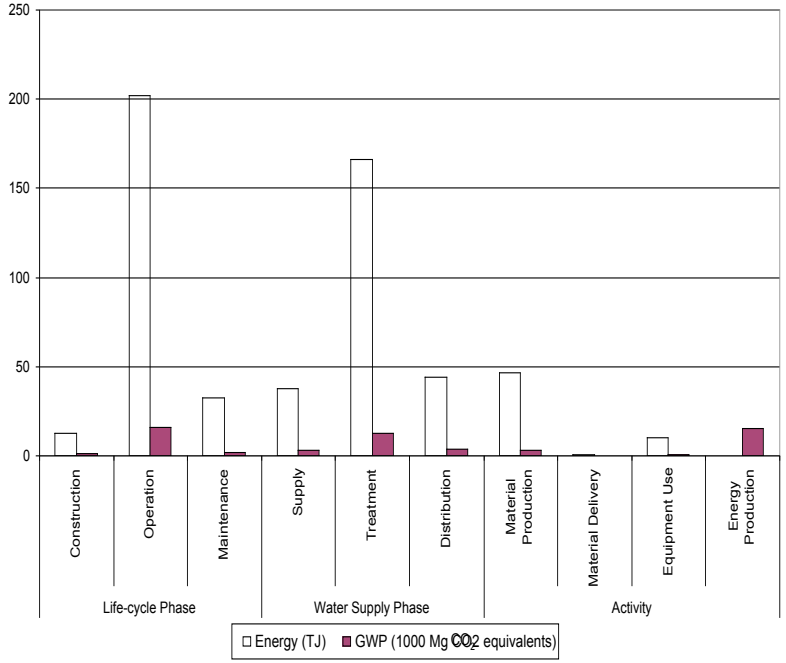


Water Energy R&D
PIER Environmental Program

Problem: ***What are the energy and environmental trade-offs between alternative water supply options for local water districts?***

Solution: ***Development of a life-cycle assessment model for evaluating alternative water supply systems in California***

Figure 7: Annual Average Energy Use and GWP Results

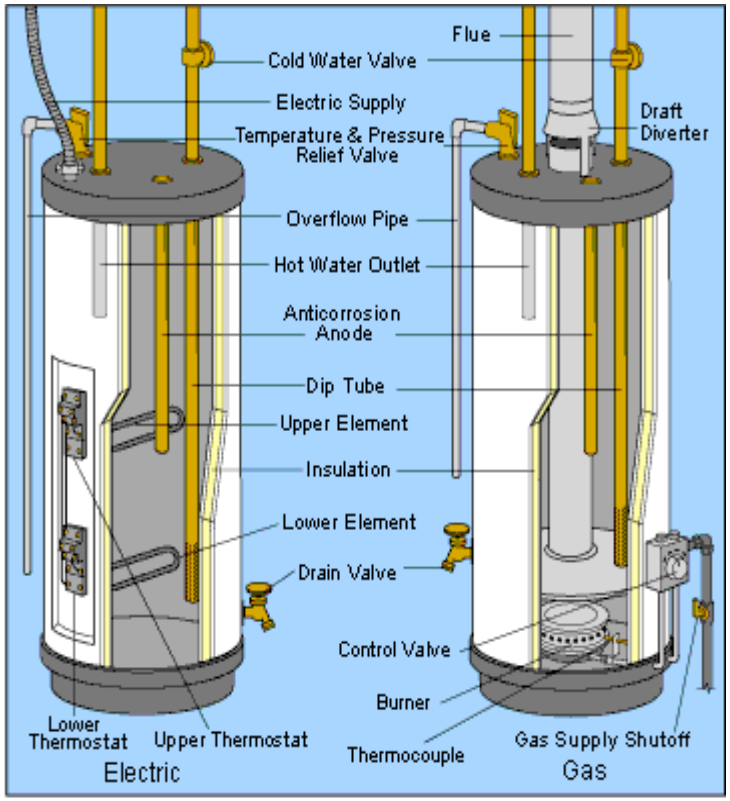


End-Use Water Heating R&D

PIER Buildings Program

Problems: ***Hot water piping in houses contributes to a significant waste of both water and energy, but these losses are not well quantified for CA's housing stock. New water heating technologies will save energy but also need to consider equipment costs, water usage and other environmental impacts.***

Solutions: ***Characterize hot water distribution systems in CA houses; Identify industry issues and quantify savings potentials for instantaneous water heaters and high efficient gas storage water heaters.***



End-Use Water Heating R&D

PIER Buildings Program (future)

Problems: ***Hot water usage in Ca houses needs to be characterized so that appropriate water and energy saving measures can be introduced through efficiency standards and utility incentives; Commercial businesses are seeking water and energy saving options that also fit their business needs.***

Solutions: ***Hot water usage field monitoring studies; research to support future water heating efficiency standards; efficient hot water system designs for specific commercial market sectors (e.g. food services & hospitals)***

Water Energy R&D

PIER Industrial, Agriculture & Water Program

Problem: ***California's rapidly growing inland communities must desalinate brackish water to meet future water needs, but cannot dispose of the brine waste by discharge into ocean.***

Solution: ***Develop a novel technical approach involving alternating applications of reverse osmosis (RO) with other processes to remove the least soluble salts that limit product water recovery in the primary RO process and thus reduce brine volume.***

.

Water Energy R&D

PIER Industrial, Agriculture & Water Program

Problem: ***Water and wastewater utilities need energy efficiency performance benchmarks of utility processes to assess efficiency improvements.***

Solution: ***Produce industry-wide energy performance metrics to describe the performance of water and wastewater utilities, which will subsequently be incorporated into a benchmarking tool to facilitate internal and external comparisons within and among utilities. This also facilitates measuring the cost-effectiveness of efficiency improvements.***

Water Energy R&D

PIER Industrial, Agriculture & Water Program

Problem: ***Aeration (mixing oxygen) of wastewater is an energy intensive step in wastewater treatment. More aeration than needed wastes energy and low aeration violates health regulations. Optimum aeration is essential. Current aeration monitoring technology is bulky, expensive, and is not deployed often enough to keep the aeration process fine tuned, resulting in wasted energy.***

Solution: ***Develop a light-weight system for accurate control and monitoring of aeration levels for optimizing oxygen uptake. This will reduce electricity demand. The new small size and light-weight equipment will encourage activated sludge wastewater treatment facilities to conduct aeration efficiency measurements in-house on a regular basis with minimal technical assistance***

Water Energy R&D

PIER Industrial, Agriculture & Water Program

Problem: ***Irrigation districts deliver water to farms using fixed water delivery schedules. Farmers want water at a time different from the fixed schedule, and resort to ground water pumping. Pumping ground water is more energy intensive than receiving surface water from irrigation district.***

Solution: ***Develop an automatic control where a gate is operated remotely by the irrigation district. Automation cuts down on energy and manpower, and gives farmers a viable option for using surface irrigation water.***

Water Energy R&D

PIER Industrial, Agriculture & Water Program

Problem: ***Water utilities need an accurate method for measuring the operational efficiency of variable speed motors used with irrigation pumps in order to establish appropriate rebates, etc. New techniques and benchmarks for determining efficiency under various operating controls and conditions need to be developed and standardized.***

Solution: ***PIER funded the Irrigation Training & Research Center at Cal Poly's Water Delivery Facility pump testing laboratory to develop techniques to evaluate efficiencies. These techniques have been applied to field conditions at cooperating irrigation district facilities. Results have been disseminated to engineers, water districts, and pumping plant evaluation companies. Proper measurement and use of variable speed drives can result in savings of up to 54,000 MWh of electricity.***

Future Water Energy R&D

PIER Industrial, Agriculture & Water Program

Near-term R&D Portfolio Planning

- R&D Opportunities Identified From Numerous Sources
- Screened to Meet Near-term R&D Needs
    - Screen 1: Responsive to EPR and WER Goals and Objectives
    - Screen 2: Consistent "Public Interest Energy Research"
    - Screen 3: Requirement or Benefit From Near-term PIER Investment
        - Near-term Opportunity That Might Otherwise Be Lost
        - Information Needed To Proceed With Future R&D Efforts
        - Partners Available or Likely – Matching Funds an Asset
    - Screen 4: Scored and Ranked Based on Weighted Risks & Benefits
- Near-term R&D Portfolio Based on Top Ranked Concepts
- Balanced Across Water Use Cycle and Available Opportunities

Future Water Energy R&D

PIER Industrial, Agriculture & Water Program

- **Example Benefits**
  - Energy and Demand savings potential
  - Leveraging opportunity
  - Preserves potentially lost opportunity if not done now
  - Fills a knowledge or technology gap that would not otherwise be Met
  - Informs future research

- **Example Technology and Market Risks**
  - What is the likelihood the technology will succeed?
  - Is there a clear market pull?
  - Is there an existing market channel such as a utility program, a regulation, or an Industry outlet?
  - Are there market partners?

Future Water Energy R&D

PIER Industrial, Agriculture & Water Program

Initial Water-Energy R&D Portfolio

Examples Of Targeted Areas:

- Develop models and methods to more accurately characterize energy use intensities within each part of the water cycle
- Develop design strategies and protocols to optimize large conveyance systems.
- Develop new technologies optimizing water and energy savings
- Develop methods for load shifting through storage & conveyance
- Load Shifting/Demand Response For Water/Wastewater Utilities
- Develop methods for recycling of industrial process water
- Develop new (and improve existing) irrigation practices

Future Water Energy R&D

PIER Industrial, Agriculture & Water Program

Five Year Strategic Plan And Roadmap – 2007-2012

- Long-term Strategic Approach To Water-Energy Efficiency
- Conduct information gathering workshops and interviews
- Identify R&D Needs And Set Goals
- Identify Market Partnerships
- Screen and Rank R&D Measures and Strategies
- Develop a Flexible R&D Roadmap and Portfolio To Reach Goals
- Strategic Planning Process Is Currently In Development Phase

Efficiency Programs

- Energy Partnership Program
  - No-Cost public agency technical assistance
  - Identifying cost-effective efficiency opportunities
    - Identifying value of energy savings
    - Identifying cost of making changes
- Low Interest Loans
  - Public Agency Energy Efficiency Projects

Efficiency Programs

- **Best Practices Workshops**
  - **Collaboration of CEC, utilities and DOE**
  - **May 2006 workshops for Water/ Wastewater treatment operators**

    Pumping System Assessment

    Motor Systems Management

    Contact vingraha@energy.state.ca.us

Contact Information

Nancy Jenkins, Manager (njenkins@energy.state.ca.us)
Energy Efficiency Research Office

- *Pramod Kulkarni, IAW Lead (pkulkarn@energy.state.ca.us)*
  - *Richard Sapudar, Water Lead (rsapudar@energy.state.ca.us)*
- *Ann Peterson, Buildings Lead (apeterso@energy.state.ca.us)*
  - *Martha Brook, Water Lead (mbrook@energy.state.ca.us)*

Laurie ten Hope, Manager (ltenhope@energy.state.ca.us)
Energy Systems Integration and Environmental Research Office

- *Kelly Birkinshaw, Environmental Program Lead (kbirkins@energy.state.ca.us)*
  - *Joe O'Hagan, Water Lead (johagan@energy.state.ca.us)*

John Sugar, Manager (jsugar@energy.state.ca.us)
Public Programs Office

- *Shahid Chaudry, Efficiency Water Lead (schaudry@energy.state.ca.us)*
- *Daryl Mills, Supervisor (dmills@energy.state.ca.us)*